



Terms of Reference for a feasibility study

Resilient water management system: Modernization of the Nile Delta barrages and the Nubaria canal

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Table of Contents

1.	Introduction	3
1.1	Presentation of AFD	3
1.2	Presentation of the contracting department and of AdaptAction	3
2.	Overall context of the consultancy	3
2.1	Water management in the Nile delta	3
2.2	Climate change impacts in Egypt	4
2.3	The modernization project	5
3.	Objectives and components of the study	12
3.1	Detailed objectives of the study	12
3.2	Water management study	13
3.3	Technical feasibility	16
3.4	Environmental and Social documentation	24
3.5	Cost estimate and multicriteria analysis	27
3.6	Project concept note and guidance for next steps	27
4.	Expected deliverables	28
5.	Implementation modalities	30
5.1	Estimated level of effort and timeframe	30
5.2	Expected methodology and coordination	31
5.3	Implementation requirements / contact persons	32
5.4	Applicable Languages	32
6.	Expected Qualifications	33
7.	Available resources	34
8.	Annexes	36
8.1	Key features and location of the Delta Barrages and Nubaria Canal	36
8.2	Hydraulic Control Structures associated with Nubaria Canal System	38
8.3	Lateral intakes along Nubaria Canal	39
8.4	Main activities of the study organized by deliverables	0



1. Introduction

1.1 Presentation of AFD

AFD Group finances and drives transition to a fairer, safer and more resilient world, working with its partners to support communities all over the world. Drawing on the complementary strengths of its entities – Agence Française de Développement for public financing, Proparco for responsible private investment, and Expertise France for technical expertise – the Group is ideally positioned to work with all stakeholders committed to economic development and the preservation of common goods. Our teams are involved in over 4,000 projects across the French Overseas Territories and in 160 countries. In doing so, we contribute to France's policy on sustainable investment and international solidarity, in support of the Sustainable Development Goals (SDGs).

1.2 Presentation of the contracting department and of AdaptAction

The study is under the monitoring of the AFD's Country office in Cairo, AdaptAction team and the Agriculture, Rural Development & Biodiversity (ARB) division.

AdaptAction¹ aims to strengthen the resilience of populations and ecosystems in 19 vulnerable partner countries including Egypt. The program covers all sectors impacted by climate change according to the priorities and needs of partner countries: water resources, agriculture, disaster risk reduction, climate services, local planning, integrated coastal zone management, transport infrastructure, cities, buildings, education, etc.

Within AFD, the Agriculture, Rural Development and Biodiversity (ARB) division, reports to the Sustainable Development Solutions (SDD) executive direction. The mission of the ARB division, in coordination with the partner countries, is to lead AFD-funded interventions in the fields of agriculture, agri-food and agri-industrial sectors, sustainable forest management and fisheries resources, the conservation and restoration of biodiversity and the development of rural areas.

2. Overall context of the consultancy

2.1 Water management in the Nile delta

As one of the most arid countries in the world, **Egypt depends almost entirely on water from the Nile River**, which originates from outside its borders. The Nile Delta is the terminal outlet of a 3 M km² basin that spans 11 countries before joining the Mediterranean Sea in Egypt. Nile water accounts for 94% (55.5 Bn m³/year) of Egypt's conventional water resources. Egypt has a water demand of 116 Bn m³/year, which leaves a 56 Bm³/year gap for the GoE to fill through non-conventional water sources (including 22 Bn m³/year through reuse of treated wastewater and 34 Bn m³/year as virtual water through imported food and goods)².

As a water scarce country, with a high annual population growth and ambitious economic development and food security objectives, the **water demand** is expected to continue to increase despite the limitation of resources. Furthermore, this scarcity will be heightened by the impacts of **climate change**,

¹ [AdaptAction: supporting climate change adaptation strategies | AFD - Agence Française de Développement](#)

² MWRI Priorities document "[Mapping out Egypt's Water future](#)"



including a rapid increase of temperature, which is already rising 20% faster than the global average in the North Africa region. Furthermore, the Nile Delta is one of the IPCC -Intergovernmental Panel on Climate Change- hotspots globally expected to be severely impacted by saline water intrusion or partial sinking of agricultural land. In a country where around 80% of the water is used in agriculture, the increase of evapotranspiration is having a significant impact on the water balance, exacerbating the gap between **sustainable, renewable water supply and demand**.

In this context, the GoE **prioritize water efficiency projects** aligned with the **National Water Resources Plan (2017 to 2037)** developed by the Ministry of Water Resources and Irrigation (MWRI). To address water scarcity, the GoE has been promoting different solutions such as wastewater treatment, agricultural water re-use, rain water harvesting, desalination. The MWRI has started implementing projects to enhance resilience, preserve ecosystems and promote socio-economic development. The **improvement of hydraulic structures** is also underway (such as the new Assiut barrages, the construction of Dairout barrage group or the rehabilitation of 47,000 hydraulic structures along the Nile valley).

2.2 Climate change impacts in Egypt

Egypt is considered highly vulnerable to climate change; it is ranked 105 on the ND Gain Country index. The uncertainty and the consequences already impacting Egypt are exacerbating the numerous challenges the country already faces:

- **Agriculture:** The challenge of sustainable agriculture is critical for the country. For instance, agricultural yields could decrease by 10 percent by 2050, as a result of heat stress, water stress, and salinity³ with several crops that could plummet as far as 28% for vegetables or 47% for rice and maize⁴.
- **Urbanization:** The growing demography and the need to expand cities or create new ones face climate change consequences such as the weakening of buildings⁵, internal migrations, urban heat and increased vulnerability to violent climate disaster. The UN estimates that Egypt's population will reach 159.9 million by 2050, up from 107 million in 2024, with 55.6% of the total population living in cities by 2050.
- **Ecosystems:** Climate change is one of the key drivers of the loss and degradation of freshwater biodiversity, which decline by 84% in the past 50 years⁶.

Egypt is characterized by a predominantly arid climate with very low annual rainfall, averaging 1.3 BCM/Year. Most precipitation occurs along the northern coast, particularly in the Mediterranean region and the Red Sea area. Despite the overall low rainfall, the intensity and frequency of flash floods have increased in recent years.

Although there is a lot of uncertainty about the inflows of the Nile in the next decades⁷, rainfall has already been decreasing by approximately 22%⁸ during the past 30 years.

³ IFPRI, 2021: *Climate-resilience policies and investments for Egypt's agriculture sector: Sustaining productivity and food security*.

⁴ FIDA, 2019: *Opportunities, challenges and limitations of climate-smart agriculture - The case of Egypt*

⁵ 2025, Reuters: Heba Fouad and Ahmed Fahmy, *Rising seas and shifting sands attack ancient Alexandria from below*.

⁶ WWF 2020: *Living Planet Report 2020 – Bending the curve of biodiversity loss*.

⁷ MedECC, 2020, *Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report*, Union for the Mediterranean, Plan Bleu, UNEP/MAP.

⁸ The World Bank Group, 2021, *Climate Risk Profile: Egypt*.



Climate Parameter	Reference period (1991-2020)	Projections
Annual temperature	23°C (whole country)	+2.1°C (whole country) (2040-2059 (SSP5-8.5))
Summer and hot days (over 35°C)	15- 20 days per year	+9 to 77 days/year (2040-2059 (SSP5-8.5))
Annual precipitation	20mm / year in Upper Egypt 200mm / year on the North coast	Wide variability of the models on the Nile Basin
Sea level Rise	+3.4 mm / year to +9.10mm/year in the central Delta	+0.38 to 0.82 meter in 2090

The Nile Delta has been identified as a mega hotspot of vulnerability in terms of climate change impacts. For example, a recent study shows that, in the worst-case scenario, sea level rise will flood 482 km² in fifty years, and 2433 km² in one hundred years⁹. Saline water intrusion is also a raising concern in the delta, as it is a major area of agriculture production in Egypt.

2.3 The modernization project

The Government of Egypt (GoE), through the Ministry of Water Resources and Irrigation (MWRI), has requested AFD's support for modernizing the management of water flows entering the Nile Delta and enhancing water security. As part of a holistic approach to rationalizing water use, the modernization and automation of the Delta Barrages and associated regulators is a core priority for MWRI. These barrages receive almost 50% of Egypt's share of Nile water, i.e. about 25 billion m³/year, to meet irrigation, drinking water, industrial, and navigation needs. The Delta covers about 22,000 km², of which more than 80% (around 5 million feddans) consists of prime irrigated land of high economic value.

The table below presents the main characteristics of the structures included within the **Group of Delta Barrages**, comprising the **two main barrages** on the **Rosetta and Damietta branches**, together with a number of **main head regulators** and **small head regulators**.

The **two main Delta Barrages**, both constructed in **1936**, form the core of the system controlling the initial distribution of water into the **Rosetta and Damietta branches**. These values underline the strategic hydraulic importance of the two main barrages in regulating normal flows, handling emergency conditions, passing flood flows, and supporting downstream water allocation across the Delta.

The table also shows that the **main head regulators** differ in age, configuration, and hydraulic capacity according to their specific function within the system. They have an important role in conveying and regulating flows toward the major rayahs and canals downstream of the Delta Barrages.

It should be noted in particular that the **Ismailia headworks consist of two adjacent structures**, namely the **Old Ismailia Head Regulator** and the **New Ismailia Head Regulator**, located side by side at the same site. Because of this configuration, both structures are subject to the **same head difference**, and the discharge entering the **Ismailia Canal** is the **combined flow passing through the two regulators together**. Therefore, although they are presented separately in the table due to their different

⁹ Hassan, S., Saleh, M., Mohamed, B. et al. 2025: *Environmental risk assessment of the Nile Delta, Egypt, based on radar interferometry, altimetry, and geodetic measurements*.



structural and operational characteristics, they are hydraulically associated and may be considered, from a flow regulation perspective, as a **single control point** for water entering the Ismailia Canal.

The **small head regulators**, such as **Al-Sharkawia**, **Al-Bassosia**, **El-Nagii**, and **Darawa**, have fewer vents, smaller vent widths, and relatively limited discharge capacities, with maximum discharges ranging from about **0.5 Mm³/day** to **3.3 Mm³/day**. This indicates that their function is more localized and serves smaller command areas compared with the main barrages and the main head regulators.

Main Barrages and Head Regulators

No	Structure name	Date of construction	No. of vents	Vent width	Min. discharge (Mm ³ /d)	Max. discharge (Mm ³ /d)
1	Delta barrage, Rosetta branch	1936	46	8	8	69.6
2	Delta barrage, Damietta branch	1936	34	8	13.4	69.5
3	New Menofi head regulator	2008	9	5	3.75	25
4	New Tawfiki head regulator	2010	6	5	3.5	16.5
5	Nasery Rayah head regulator	1972	6	5	2.5	11
6	Behairy Rayah head regulator	1935	6	8	8.75	28
7	Old Ismailia head Regulator	1902	3	5	10.5	22.75
8	New Ismailia head Regulator	1976	4	8		

Small Head Regulators

No	Structure name	Date of construction	No. of vents	Vent width	Min. discharge (Mm ³ /d)	Max. discharge (Mm ³ /d)
1	Al-Sharkawia Head Regulator	1939	5	2.25	0.5	3.3
2	Al-Basosia Head Regulator	1919	3	3	0.25	1.4
3	El-Nagail Head Regulator	1936	2	3	0.1	0.75
4	Darawh Head Regulator	1936	2	3	0.05	0.5

The initial design of the two main barrages considered annual flood discharges of about 1.1 billion m³/day, in addition to raising upstream water levels to feed the major and main canals of the Delta. Following the completion of the High Aswan Dam, and considering the absorption capacity of the Toshka Spillway in the event of floods, the maximum discharge at the barrages was reduced to about 0.6 billion m³/day, thereby eliminating the need for the largest gates originally envisaged.

Given the age of the barrages, a structural, hydromechanical, operational, and automation upgrade is now required. Such modernization, combined with the implementation of a centrally controlled automation system in place of the current largely manual crane-based operation, would unlock significant potential in terms of reduced operation and maintenance costs and improved water management performance. In addition, the new operating mode is expected to contribute to disaster risk reduction, particularly in the context of climate change, where more frequent and intense extreme events, including flash floods, may be anticipated.

In this context, the GoE has requested AFD's support to finance a study for the modernization and automation of the Delta Barrages system. This support was confirmed at the end of 2024, with AFD



committing to finance a study structured in two stages: (i) a scoping study carried out by Société du Canal de Provence (SCP), and (ii) a feasibility study based on the conclusions of the scoping study. The present Terms of Reference (ToR) correspond to this second stage.

The project focuses on the structures presented in the table above, namely the two main barrages and the five head regulators included within the study scope, together with the Nubaria Canal system as a priority downstream interface for extending modernization toward the Western Nile Delta. The Nubaria Canal extends over approximately 117.00 km, starting at km 0.00, located at km 82.10 on Rayah El-Behairy, and ending at km 117.00. In addition to its main supply from Rayah El-Behairy, the canal also receives water from the tail end, or outfall, of Rayah El-Nassery, which extends for about 83.470 km from the Delta Barrages and discharges into the Nubaria Canal at km 7.00 on the left bank. This further highlights the strategic role of the Nubaria Canal as a key hydraulic corridor within the Western Nile Delta system (Annex 8.2 & 8.3).

The institutional owner of the project is the Ministry of Water Resources and Irrigation (MWRI), as the authority responsible for managing Egypt's water resources and ensuring that local water demands are met. MWRI has issued the National Water Resources Plan 2017–2037, which sets out the strategic pillars for sector development. The Ministry also has an active planning function that plays a pivotal coordinating role with other technical ministries and their implementing agencies, the Ministry of Foreign Affairs, International Cooperation and Egyptian Expatriates, and international financial partners. Internally, this planning function also coordinates with MWRI technical experts on feasibility studies, preparation of scopes of work, design review, data collection, and related technical inputs.

Three entities of MWRI's Irrigation Department will be directly concerned by the project: the Reservoirs and Grand Barrages Sector (RGBS), the General Administration of Delta Barrages (Qanater), and the Irrigation Sector. The Consultant will therefore be expected to interact closely with the relevant stakeholders both within and outside MWRI throughout the feasibility study

2.3.1. Objective of the project

The general objective of the project is to **optimize a climate resilient use of water resources through a rational and sustainable control of the flows entering the Nile Delta area.**

The proposed modernization shall:

- Ensure a fair and long-term water management supporting sustainable needs (especially farmers' needs) in the context of climate change and uncertainties
- Modernize the operating and control systems of the Group of Delta Barrages¹⁰
- Improve the water security throughout Nubaria canal
- Reduce the operation and maintenance costs of the related water infrastructures

These objectives shall be achieved through:

1. A reduction of the water leakages due to the rehabilitation of the gates and a reduced number of active gates resulting from the hydraulic optimization
2. A reduction of the water losses in the operation process due to a more adequate timing of operations resulting from the gates' automation
3. A rationalized water allocation, favoring an allocation process more adjusted to the downstream demand thanks to the dynamic control of the barrages

¹⁰ The project encompasses all the barrages and head regulators listed above as well as the Nubaria canal



2.3.2. Components of the project

This feasibility study is related to two components of the project presented in the scoping report:

Component 1: Modernization of Delta Barrages

The first component focuses on the modernization and automation of the group of delta barrages. It aggregates several activities of studies, design, works and technical assistance to implement the modernization of the barrages. Three subcomponents were identified in the scoping report:

- Preparation of a fair Delta water management plan
- Rehabilitation and automation of Delta Barrages gates
- Development and implementation of a dynamic control system (incl. Monitoring & Information System)

Component 2: Modernization of Nubaria Canal Control System (Western Nile Delta)

The second component of the scoping report initially targeted Ismailia Canal. While keeping the same objective for this component, MWRI decided to shift its implementation on **Nubaria Canal**. It will be a pilot chain of command to further develop the modernization and (where feasible) automation of water management in the **Western Nile Delta**. Within the Government of Egypt's gradual Nile Delta modernization program—supported by international partners including **AFD**—the Nubaria Canal is a strategic water corridor supplying large-scale agricultural developments, agro-industrial activities, and newly reclaimed areas. The canal receives its water from **Rayah El-Behairy and Rayah El-Nassery**, which abstract from the Nile upstream of the **Delta Barrages**, making Nubaria an ideal system to strengthen coherence between upstream regulation and downstream water use.

This component has been prioritized to avoid duplication with parallel modernization initiatives on other canals (such as Ismailia, which was initially proposed in the Scoping Study) and to focus the feasibility work where key gaps remain—particularly limited monitoring coverage, complex and evolving demands (agricultural, industrial, and reclamation), hydraulic/operational constraints, and fragmented data and decision processes. The overall purpose is to achieve end-to-end coherence of the modernization process—from the headworks/interface regulation points to tail-end uses—by anchoring operations in reliable measurement, transparent information flows, and model-supported, scenario-based decision making.

Four interlinked subcomponents are identified:

- Analysis of the water security situation on the Nubaria Canal system
- Rehabilitation and modernization of key water management facilities along Nubaria Canal
- Development and implementation of a Dynamic Control framework (including a Monitoring & Information System) for Nubaria Canal-
- Building technical, financial, and institutional capacity of operators and water users

2.3.3. Comments on the modernization benefits and challenges

The improvement in the rational use of water resources controlled by the barrages' gates relies on **allocation decisions (in times and volumes¹¹) being based on actual aggregated water demands**, estimated and/or formulated. The main challenge is to have a reasonably good picture of those demands, industrial and domestic and most importantly irrigation needs. The process of assessing irrigation water demands from the lower level (farm plots/mesqas) and aggregating these up to country-level is complex. It is a dynamic process that must rely on cropping information as well as

¹¹ It is important to keep in mind that water releases in the Nile River are controlled at High Aswan Dam. There is negligible storage downstream and all the way to the Delta and the Mediterranean Sea



weather considerations. A dual-based approach (both supply¹² and demand driven) information system is needed for the collection and processing of a multi-dimensional data set addressing uncertainties and extreme climate situations. While some of the information needs can come from technology (for example satellite pictures), it is still essential to engage stakeholders through a proper governance setup.

2.3.3.1 Climate change adaptation

Climate change will exacerbate Egypt's current vulnerabilities, with the potential to deepen persistent demographic growth¹³ and spatial disparities. Densely populated cities and urban areas in the Nile Delta will be significantly impacted by the combined effects of sea level rise (SLR), increasing coastal and flash flood events as well as water availability challenges. Climate change increases the uncertainty in availability of water resources in the country, increases in frequency and intensity of extreme events (droughts and significant floods) affecting biodiversity, and threatens food security and availability (increase in evapotranspiration and therefore in water needs for agriculture). Estimates for Egypt suggested that by 2060 the combined impact of climate change will represent between 2% and 6% of Egypt's GDP.¹⁴

The NWRP 2037 recognizes the challenge posed by increased water scarcity and estimates a reduction in per capita drinking water allocation from 309 litres per capita per day (lpcd) to 242 lpcd by 2037, even as total demand will increase from 11.5 billion cubic meters (BCM) to 13 BCM.

Any improvement in the rational use of water resources must consider the impacts that climate change on both water availability and needs, along with uncertainties around those predictions:

- As mentioned earlier (§ 2.2), Nile inflows may decrease, while evaporation losses may increase with average temperatures; and
- Crop water needs (evapotranspiration) will increase accordingly

Any planning of future water allocations in the Delta must consider available climate change predictions as these will impact both water availabilities and demands.

The project will have to be aligned with the Paris Agreement (i.e. see the low-carbon and resilience dimensions based on AFD scoring matrix for sustainable development), and the ambition regarding climate change can be summarized as follow:

Low-Carbon transition

The present study will systematically take into account the vulnerability of the project to climate change and evaluate its consistency with the Egyptian long-term strategy, the Nile Delta level pathway and relevant climate commitments (energy used, water loss reduction, sobriety).

The potential solutions and activities (including data collection and stakeholders' coordination) that might moderately contribute to the carbon pathway will be identified.

¹² Upstream development uses and changes in land use in the Nile watershed impacting the Nile's supply

¹³ The UN estimates that Egypt's population will reach 159.9 million by 2050, up from 107 million in 2024, with 55.6% of the total population living in cities by 2050. Demand will be higher for electricity, water and food, as well as health and education service. In Greater Cairo alone, the urban population is expected to increase by 36% to 28.5 million by 2035

¹⁴ Estimates consider changes in water supplies, agriculture, air quality, heat stress, and tourism. Other sensitive sectors, including water pollution, energy consumption, and biodiversity, are not included in this assessment of impacts. Smith JB, McCarl BA, Kirshen P, Jones R and others (2014) Egypt's economic vulnerability to climate change. *Clim Res* 62:59-70. <https://doi.org/10.3354/cr01257>



Climate change resilience

The project as a significant ambition in terms of contribution to climate resilience. The study will help define the right path for the adaptation of the modernization process and recommend dedicated measures (e.g. dynamic monitoring of water quality including salinity level; facilitation of the migration of species...). To enhance climate resilience, the project will include a coordinated water supply and demand system as well as capacity-building actions.

2.3.3.2 Potential environmental impacts of the project

The scoping report discussed four main environmental impacts associated with the optimized regulation of water flow entering the Delta:

Reduction of the Nile Delta discharge to Mediterranean Sea

The Nile delta is a closed system, and each loss is a potential source for a high level of water recycling: seepage of the unlined canals feeds the Nile aquifer that offer a source of groundwater; basin irrigation plays as capital leaching and feeds the fresh aquifer that prevent saltwater intrusion.

The change in the share of water flowing to the drains and to groundwater could eventually have the following negative effects:

- Saltwater intrusion (which will increase with sea rise related to climate change);
- Erosion and shoreline retreat;
- Decrease of nutrients exported to coastal ecosystems.

However, water quality indicators (salinity and pollution levels) could be dynamically considered in the future automated water management system of the barrages to more rationally manage the discharge to the mediterranean sea.

Obstacles to upstream or downstream migration of species

The changes in barrages management along the Nile Delta could disrupt the migration of aquatic species (Nile perch, tilapia sp., aquatic invertebrates), by hindering species that migrate upstream or downstream in order to realize their spawning, breeding or growing phase. These disruptions could affect population dynamics and eventually ecosystem balances as species may struggle to reach their spawning grounds or suitable habitats due to altered water levels, current speeds, and temperatures. Additionally, changes in seasonal flooding could impact the availability of food and habitats, further disrupting migration patterns.

Modification of sedimentary dynamics upstream and downstream of the headworks

The rehabilitation will likely result in the permanent closure of certain barrage gates (horizontal regulation), or to a revision of their opening pattern (vertical regulation). As a consequence, the sedimentary dynamics may be disturbed, evolving towards a new equilibrium that could possibly alter the bathymetry downstream of the barrages, with potential creation of islets and over depth.

These changes could ultimately impact species distribution, by changing the hydrodynamic conditions, and the navigability of the delta's branches.

However, the automation of the group of delta barrages could bring interesting opportunities to better manage the drainage of the flows in the downstream parts of the delta by offering more rapid and tailored water allocation from upstream to downstream.

Limited impact on biodiversity

The project will have an overall impact on the management of water resources in the area (upstream and downstream of infrastructures) but no residual impacts on biodiversity and natural resource are



envisioned. The study will identify mitigation measures (such as operating rules compatible with environmental flows and the connectivity of aquatic ecosystems) to avoid such degradation. The dialogue around long-lasting water availability, awareness and access to information relevant to natural resources management will also foster this dimension.

2.3.3.3 Potential social impacts of the project

The design of the project should mitigate the potential decrease of family farmers food security and livelihood linked to water insecurity as a consequence of:

- lower water quantity (less water leaks & groundwater storage) and quality (less salinity dilution) at the network ends in the Delta;
- loss of arable land due to natural subsidence, amplified by increased pumping in the aquifer to fill the water deficit at the end of the network, and the increased intrusion of saline water in the North of the Delta
- reallocation of water to new areas in the eastern and western margins of the Delta for the benefit of larger farms.

Social link

The project should at least avoid any deterioration in living conditions or non-inclusive access to water. Moreover, a transparent and territorial approach will support the design of a Fair Delta water management plan and the monitoring system to enhance water allocation to marginalized areas.

2.3.3.4 Potential economic and governance impacts of the project

Potential water savings if fairly and inclusively shared among the delta shall limit water scarcity, improve agricultural production and food security and indirectly allow for the creation of agricultural jobs. The impact of the project on agriculture performance would be amplified if the modernization is connected to downstream regulation (fine assessment of the need for irrigation in quantity and availability at the required times) and supported with more sustainable practices limiting the contamination of water, soil, plants and fish with pollutants.

At a more local scale, the project aims to enhance the efficiency and reduce the maintenance costs of gate operations and crane management of the headworks, which will have a positive economic effect. An analysis of the current operation and maintenance costs is needed in order to quantify this effect.

Economy

Given that adequate water management is at the foundation of the automation system to sustainably answer to agricultural demands as well as other sectorial needs while taking into account climate and demographic impacts; the project contribution to a more balanced territorial economic development with future changes is ambitious. The study will objectivate the achievable target based on different scenarios of the project economic impacts (water savings, enhanced water quality, value chains supported, creation of sustainable and decent local jobs...).

Increasing on-farm water use efficiency can potentially increase yields with the shift from gravity to localized irrigation. Similarly improving conveyance with the modernization of each element of the system (Canals and head regulators) can also propose gains in efficiency.

Governance

The implementation of the Delta water management plan along with the road map for stakeholders' engagement and an effective monitoring of water allocation contribute to the governance dimension of the project. Indeed, automation and real time monitoring and control gives a solid opportunity to more transparency in water management in addition to favoring a coordinated governance of water



supply and water demand governance. However, the governance arrangements of the project must prevent the disconnection of the decision to open valves for water allocation in the different branches from the local context and needs.

The logical framework provided by the present study will support this ambition with guidelines regarding water governance, integrated planning, monitoring, intersectoral coordination and accountability tools.

3. Objectives and components of the study

This feasibility study shall assess the technical (structural and management), financial (and economic), as well as socio-environmental and institutional dimensions of the project to inform MWRI, AFD and AdaptAction decision makers.

3.1 Detailed objectives of the study

Project approval requires a comprehensive feasibility study to establish clear guidelines for the optimization and modernization of water management at the Delta Barrages system and its downstream interfaces serving the Western Nile Delta, with a specific focus on Rayah El-Behairy, Rayah El-Nassery, and the Nubaria Canal system. The study shall also identify project risks and potential sustainable development issues in line with the AFD sustainable development scoring matrix (cf. § 2.3).

The overall objective of this feasibility study is to assess the current and long-term operational performance of the Group of Delta Barrages, including the two main barrages controlling flows to the Damietta and Rosetta branches, together with the five head regulators, namely Rayah El-Nassery, Rayah El-Behairy, El-Menoufi, El-Tawfiki, and Ismailia Head Regulator, and to determine how modernization and data-driven operations can enhance allocation reliability, operational transparency, and climate resilience for the Western Nile Delta command areas, particularly the Nubaria Canal system, which receives its water from both Rayah El-Behairy and Rayah El-Nassery. The study shall also confirm the relevance of the project concept and provide the basis for further discussion under AFD's mandate and the AdaptAction financing framework.

Specifically, this includes -but not limited- to the below activities:

- Assess how to ensure maximum benefits from the modernization in terms of improved water allocations to the Delta, which heavily rely on proper information regarding water needs, essentially from irrigation; and also define the governance and institutional requirements for successful implementation, while considering the sustainability of the project vis-a-vis climate change impacts.
- Review, determine, and evaluate the technical activities needed for the modernization (automation and structural upgrade) of the Group of Delta Barrages as well as the Nubaria canal. This would include the necessary hydraulic modelling, reservoir modelling and definition of design principles of a monitoring and information system. In addition, preparation of the operational foundations for a Dynamic Control and Decision-Support framework
- Provide an analysis of environmental and social risks of the project (along with the carbon footprint)
- Analyze and describe possible impacts of the project on management of natural resources and biodiversity, either negative and positive impacts in a context of climate change.



- Develop an initial cost estimate of all project activities, and a preliminary economic analysis of expected impacts.
- Provide the project concept note and define the next steps for the implementation of the project (including pre-implementation studies, governance and institutional activities, capacity building needs, as well as risk mitigation actions for a sustainable project).

3.2 Water management study

As mentioned earlier, the main benefits of the modernization project are a reduction of water losses from leakages and slow manual operation as well as a **rationalized water allocation in a context of climate change**.

This second benefit is the most important one, and relies on responsive allocation decisions (in times and volumes) based on water supply and aggregated demands, estimated and/or formulated. The main challenge here is to have a reasonably good picture of those demands, industrial and domestic and most importantly irrigation needs who are by far the largest water use in the Delta.

3.2.1. Objectives of the water management study

The main objective of this activity is to prepare the design and implementation of a **planning and management tool** to be developed under the future project. A fair **Delta Equity Water Management Plan** will support **sustainable, equitable, and efficient** water management under evolving conditions. Based on a territorial and long-term strategic vision for Delta development, the plan will be informed by scenario analysis that considers **climate change**, the ongoing **modernization program**, and its potential impacts on water availability, demands, and operational performance.

More specifically, the objectives of the feasibility study are to:

3.2.1.1. Clarify the main challenges related to water demand and water availability under climate change

- Assess demand drivers (quantity and quality), including agricultural demands and (where relevant) agro-industrial and new reclamation developments.
- Analyze water availability and system constraints under climate change scenarios, including **stress-tests of extreme events**, to establish a robust knowledge base up to **2050 and 2100**.

3.2.1.2. Characterize and assess water management governance and operational mechanisms

- Analyze the governance and institutional arrangements for water management in the **Delta and the Western Nile Delta system**, with a specific focus on **Rayah El-Behairy / Rayah El-Nassery and the Nubaria Canal**.
- Describe the ecological and institutional landscape and the operational decision mechanisms, including: **data integration**, supply-demand matching approaches, and the definition of **relevant indicators** to be embedded in the **Monitoring & Information System** supporting the modernization project.



3.2.1.3. Identify climate adaptation pathways and solutions at multiple system levels

- Analyze adaptation pathways and solutions relevant at different levels of the project area (Basin, Delta, **Delta Barrages**, Rayahs, **Nubaria Canal**), ensuring coherence and avoiding maladaptation.
- Develop cross-scenarios combining climate change and the evolution of reclaimed agricultural land, and formulate recommendations on the potential impacts of large-scale agricultural developments, agro-industrial activities, and newly reclaimed areas in the Western Nile Delta on water allocation balance and the equity of water management, in line with the rationale for selecting the Nubaria Canal as presented in the introduction to Component 2 (cf. 2.3.2).
- Identify complementary interventions that may be required to achieve resilient and equitable outcomes (e.g., monitoring upgrades, operational rule improvements, capacity building).

3.2.1.4. Provide guidelines for the elaboration and implementation of the Delta Equity Water Management Plan

- Define the methodological framework, data requirements, modeling and scenario approach, stakeholder engagement needs, and governance arrangements for developing and implementing the plan.
- Ensure alignment with modernization investments, operational capacities, and long-term sustainability objectives

3.2.2. Activities related to the delta water management plan

To formulate the strategic vision supporting a resilient and fair delta water management plan, the Consultants will use the following approach:

- **Interact with MWRI** to understand the process for deciding water releases and allocation upstream and downstream the barrages.
- Review **existing studies** that support this decision-making, including possible **relevant models** and their validity, focusing on:
 - Current and future water demands (domestic, industrial and agricultural) and water availability at different levels of the project area (Basin, Delta, Delta Barrages, Western Nile Delta system – Rayah El-Behairy/Rayah El-Nassery, and Nubaria Canal).
 - Social and environmental issues mentioned in § 3.4.
- Review the **operational process and governance system** underlying:
 - The data collection related to water needs from the end-user to central level (e.g. real-time or seasonal cropping plans) as well as water flows (quantity and quality)
 - The decision of allocation from central level to districts and to farmers
 - The interactions between stakeholders, starting with farmers, WUAs, local and national authorities.

This approach will support the achievement of the following sub-activities:

3.2.2.1 State of the art on water flows from the High Aswan Dam to the sea

The consultant shall complete the resources identified (cf. §5.2 and §7) by carrying out interviews and investigations. Hence, the outcomes of this section will be a bibliographical review and water management recommendations in the perspective of climate change. The review of the data,



modelling tools, regulatory framework, and documents might point out potential gaps for a strategic and robust water management plan.

The consultant shall also provide recommendations in the perspective of climate change drawing on:

- lessons-learned from major past and recent works at the different scales: Nile Basin, Delta and Nubaria Canal
- analysis of strategies, projects and works in progress or planned in the short term.

Consultations may be conducted through workshops and bilateral interviews with stakeholders (MWRI, the focal point on Adaptation in the Ministry of environment, research centers, institutional entities at different level, financial and technical partners). The methodology and participation strategy will be proposed by the consultant and validated by AFD and MWRI.

3.2.2.2 Specific analysis around the Delta barrages and Nubaria Canal

Building on relevant studies, the Consultant will analyze specific topics of interest to inform the design of the project, with particular attention to the impacts of climate change and other issues identified (cf. § 2.3.3). The proposal shall encompass the following tasks.

Ecosystems and ecological flows analysis under climate change scenario in the delta

The Consultant shall first analyze the overall ecological health and vulnerabilities of four ecosystems, namely a wetland in the Delta, a wetland on the Northern Coast, a representative area within the Nubaria Canal system (Western Nile Delta), and an area close to the Damietta or Rosetta Barrage.

It shall then assess the potential impacts on those ecosystems in light of new water dynamics under different scenarios of climate change and modernization. For example, local species might be affected positively or negatively by the modernization, and special attention shall be given to the transit capacity of species across the modernized infrastructures.

The Consultant shall formulate recommendations and solutions to avoid damage and assess potential opportunities for restoration. Nature-based solutions shall be considered and promoted, where feasible. The identification and prioritization of solutions shall be validated through workshops. Positive impacts of the project activities on ecosystem services shall also be described and characterized.

Agro-social analysis of the current and future evolution of the Delta

According to a recent study conducted by researchers from the International Water Management Institute (IWMI), the irrigation area in the Nile Basin is projected to increase significantly by 2050. Managing salt accumulation and preventing groundwater overextraction are critical for preserving the biodiversity in the coastal lake while sustaining agriculture and aquaculture.

The Consultant shall carry out an in-depth socio-economic analysis of the agricultural sector in the Delta in light of its vulnerabilities to climate change and in the perspective of modernization at barrage level, including local perceptions and a prospective vision. The proposal shall include a methodology defining, for example, the number and type of agricultural households to be surveyed in representative areas (at least four different areas of the Delta, including aquaculture and the Nubaria Canal system), in order to assess current water demand and its expected evolution across different time horizons (2030, 2050, and 2100).

Multisectoral analysis of the impacts of climate change and the modernization program

The consultant will have to conduct additional studies to approach the impact of climate change and the modernization envision on: disaster risk management in the delta as well as water need for



urban development, industry and tourism. After a collaborative assessment the current situation and its evolution, the consultant shall provide recommendations and technical solutions to optimize water management.

3.2.2.3 Guidelines for a robust and sustainable Delta water management plan

Prospective workshops and desirable adaptation pathways

Workshops gathering relevant stakeholders will be organized to share the main conclusions of the above analysis, define the existing information system (data collection, integration, analysis, decision) and institutional setups for water allocation, identify necessary improvement to better inform short term (management) as well as long term (planning, policy reforms) decisions, conclude on a first draft of a desirable adaptation pathways.

Prepare the design and the implementation of a sustainable and robust Delta Water Management Plan

Based on the above multi-scale analysis (at the basin, Delta and Nubaria scale) and the comparative analysis of the different scenario, the Consultant shall propose draft ToRs for the development of a **fair water management plan for the Delta** maximizing the benefits of the modernization program and including a disaster risk management plan.

3.2.2.4 Operational capitalization and capacity building activities

The Consultant shall assess and define the capacity-building and governance framework required to ensure the sustainable, coordinated, and effective operation of the upgraded systems. This task shall cover both the barrage level and the downstream operational interfaces related to the Western Nile Delta, with particular attention to the institutional, technical, operational, and data-management capacities required for long-term implementation.

To disseminate, the consultant will:

- Deliver capitalization/communication materials summarizing the outcomes of the study (main conclusions for stakeholders, detailed recommendations for steering institutions, conditions required to ensure long-term ownership)
- Facilitate a capacity building workshop to sensitize the stakeholders on key results and cross-sectorial futures

To capitalize, the consultant will:

- Provide strategic and organizational lessons and feedback on the results and methodology deployed
- Analyze the knowledge created through the activities (especially gate operation and automation, monitoring and telemetry systems, hydraulic and water management modelling tools, data interpretation, operational decision-support, and emergency response procedures) and suggest further improvement
- Identify the technical, operational, and managerial capacity-building needs of operators, engineers, planners, and decision-makers involved in the future operation of the Group of Delta Barrages and the Nubaria Canal system.

3.3 Technical feasibility

The technical feasibility study shall assess the structural, hydraulic, hydromechanical, operational, and institutional dimensions of the modernization of the Group of Delta Barrages and its interfaces with the Western Nile Delta system. It shall also assess the capacity of the Nubaria Canal system to support



a future integrated water management modernization process consistent with the upstream regulation logic of the Delta Barrages and the operation of Rayah El-Behairy and Rayah El-Nassery.

Core technical analyses required to support feasibility shall be considered integral parts of the study. They shall rely primarily on existing data and documentation, complemented, where necessary and justified, by targeted field investigations, surveys, measurements, and model development activities sufficient to establish a robust feasibility-level diagnosis and option analysis. In particular, the technical feasibility study shall include:

- the structural integrity and operational condition of the two main Delta Barrages and the five head regulators included in the study scope
- the hydraulic optimization of the gates to minimize the number of openings without significantly increasing discharge velocities;
- the hydromechanical upgrading of the gate mechanisms and associated operating equipment;
- the definition of a dynamic control and distribution framework at barrage level;
- The confirmation of the capacity of the Nubaria Canal to accommodate the future project, not only from a mechanical perspective, but also in terms of its ability to support resilient and reliable water distribution to end users through an adequate information system and other relevant supporting components

The Consultant will deliver guidelines for tendering detailed engineering design and works supervision for the modernization of the barrages.

3.3.1 Structural analysis

The Consultants will perform the following activities:

- Analyze existing visual investigations of civil works (surface and submarine)
- Conduct on-site visual investigations of existing barrage gates
- Conduct on-site investigations of mechanical and electromechanical moving devices (Chains, cranes, motors...)
- Identify leaking gates and joints
- Review operating and maintenance procedures of the gates
- Examine available topographic surveys of the barrages and headworks, together with available bathymetric surveys of the river beds and canals, prioritizing existing data covering up to 4 km upstream of the Delta Barrages and 2 km downstream. Given the budget constraints at this stage, the feasibility study shall rely primarily on existing surveys and limited complementary investigations to confirm key assumptions, while more extensive survey campaigns shall be considered during the subsequent pre-implementation phase after project approval
- Review existing studies and data regarding geology, geotechnics and headworks footings
- Map sedimentation dynamics and describe sedimentation situation
- Produce a diagnosis report of the overall stability and sustainability of the structures regarding a change in operational mechanism and procedures and the resulting flows. Recommend additional investigations needed for the Detailed Engineering Design phase.

Following this initial structural analysis, the Consultant shall undertake the field investigations necessary to complete the preliminary diagnosis of the barrage situation. These investigations shall form an integral part of the feasibility study and shall be defined on the basis of the review of existing data and the needs of the technical assessment. Such investigations may include, as relevant, topographic and bathymetric surveys, water quality and turbidity measurements, sediment



characterization and laboratory analysis, geotechnical investigations of the headworks, visual investigations of civil works (surface and submarine), digitalization of existing data, and digitalization of technical drawings with verification of dimensional accuracy.

Given the budget constraints at this stage, the feasibility study shall rely primarily on existing data and documentation, complemented by selected and targeted field investigations sufficient to confirm key assumptions and provide a robust basis for technical diagnosis and option analysis. Where more extensive field campaigns are required, the Consultant shall clearly identify them and recommend a detailed budget for the subsequent detailed design or pre-implementation phase.

The Consultant shall provide, in the annexes of the report, an estimate table of unit prices for each type of field investigation and analysis that may be required in subsequent phases, including, as relevant, bathymetric surveys, topographic surveys, water quality and turbidity analysis, sediment analysis, geotechnical investigations, visual investigations of civil works, and digitalization activities including dimensional accuracy checks. These unit prices shall include, where applicable, the costs of sampling, laboratory testing, interpretation of results, and report production.

3.3.1.1. Submarine bathymetric survey of Headworks for Damietta and Rosetta

The Consultant shall carry out targeted submarine bathymetric surveys of the headworks of the Damietta and Rosetta Barrages, relying primarily on available existing data and complemented, where necessary, by selected additional surveys to support the feasibility analysis. The scope of these surveys shall remain proportionate to the objectives of the feasibility study and the available budget.

Survey coverage may extend up to approximately 4 km upstream of the Delta Barrages and 2 km downstream, with 25 m cross-sections and data density. This shall be proposed by the Consultant in his technical proposal. The objective shall be to improve understanding of bed levels, scour features, and sediment deposition patterns affecting hydraulic performance, structural safety, and modernization options.

The Consultant shall integrate bathymetric data with available topographic and historical survey information in order to produce consistent geo-referenced datasets suitable for technical assessment and future model development. The Consultant may also establish or verify the survey reference framework and benchmarks required for consistency between available and newly collected data.

Selected complementary measurements, may include limited verification of flow conditions, water surface slopes, or sediment characteristics at critical locations, strictly to the extent necessary to support diagnosis and model preparation. More extensive measurement campaigns, inventories, and repeated field monitoring programs, if required, shall be identified and recommended for the subsequent detailed design or pre-implementation phase.

For budgeting and procurement-preparation purposes, the Consultant shall provide, in the annexes of the report, the assumptions used for defining the survey scope and an estimate table of relevant unit prices, including where applicable the costs of sampling, analysis, interpretation, and reporting

3.3.1.2. Semi-detailed bathymetric survey of the upper pool

The consultant shall:

- Perform a semi-detailed bathymetric survey of the upper pool, extending 30 km upstream and 20 km downstream of the barrages, with survey sections spaced at 500 m intervals.



- Collect available historical bathymetric, hydraulic, hydrological, and operational data related to the Group of Delta Barrages.
- Review data quality, consistency, and temporal coverage.
- Digitalize and organize datasets into a structured database suitable for numerical modeling.
- Identify missing or unavailable data and recommend how such gaps can be addressed through additional field measurements.

3.3.1.3. Water turbidity and sediment characterization

The Consultant shall carry out selected measurements of water turbidity and sediment characteristics at critical upstream and downstream locations. These investigations shall support the understanding of sediment-related conditions affecting hydraulic performance, erosion and deposition patterns, structural safety, and future modernization options.

Such investigations may include, limited field measurements of turbidity, selected suspended and bed sediment sampling, and laboratory analysis of key sediment characteristics, including grain size distribution, sediment concentration, specific weight, and other relevant physical properties.

Approximately 20 bed material samples may be collected from selected critical locations, using a Van Veen grab sampler. To the extent practicable, bed material samples shall be collected at the same locations where spot velocity vertical profiles are measured, in order to ensure consistency between hydraulic observations and sediment characterization. The results shall support the preliminary technical diagnosis, complement the review of available bathymetric and hydraulic information, and inform the design of any additional rip-rap protection that may be required during the modelling and subsequent design stages.

The scope of this task shall remain limited to feasibility-level diagnosis and shall avoid duplication with bathymetric survey activities and sedimentation modelling tasks. Any need for more extensive sediment investigations, repeated monitoring, or broader sediment transport analysis shall be clearly identified and recommended for the subsequent detailed design or pre-implementation phase.

3.3.2 Hydraulic analysis of the management of the gates

The Consultant shall:

- evaluate the potential for reducing the number of operational gates;
- assess possible horizontal modifications to the barrage layout, including vent closure or a reduction in the number of gates, where technically justified;
- explore possible vertical adjustments to gate travel and sill levels;
- assess the feasibility of using locks or other appropriate arrangements for emergency water discharge, where relevant, in order to reduce gate usage and associated water losses;
- explore repurposing options for decommissioned gates, where applicable;
- develop and compare alternative modernization scenarios under different operating conditions, including normal conditions, minimum demand, maximum demand, and emergency situations; and
- recommend the most effective adjustments in the number, position, size, and operation of gates to be retained after modernization.

This analysis shall build on available studies, models, and operational data, as well as on consultations with gate operators and the relevant MWRI entities.

3.3.2.1 Hydraulic numerical modelling for the Group of Delta Barrages

Hydraulic numerical modeling (HEC-RAS or equivalent)

The Consultant shall:



- develop or refine a bidimensional hydraulic model of the Group of Delta Barrages using HEC-RAS 2D or an equivalent internationally recognized tool;
- use the model to test alternative options for the vertical and horizontal modernization of the gates;
- calibrate and validate the model, to the extent feasible, using available historical data and selected complementary data collected under the feasibility study;
- simulate water levels, flow distribution, and operational scenarios, including gate opening and closure strategies;
- assess system performance under different hydraulic and operational conditions;
- evaluate alternative modernization scenarios and their impacts on upstream water levels, sedimentation tendencies, and downstream flow conditions; and
- assess upstream storage behaviour and estimate the operational storage volumes associated with the active Delta Barrages under different gate configurations and hydraulic scenarios.

The Consultant shall also precise in his offer the following:

- the assumptions adopted for the modelling scope; and
- an estimate of the corresponding effort, including relevant unit prices and/or person-days.

Barrage Model (HEC-ResSim or equivalent)

As part of the Barrage model scope, the Consultant shall:

- complement the hydraulic analysis with an appropriate pool or reservoir simulation model using HEC-ResSim or an equivalent tool;
- assess the operational behaviour of the two main barrages (Damietta and Rosetta) and their associated upstream storage under alternative operational scenarios;
- use this analysis to support the assessment of operational flexibility, allocation timing, and system response under different hydraulic conditions; and
- identify, potential downstream protection or operational measures associated with the proposed modernization scenarios.

Bidimensional model for sedimentation dynamics

As part of this scope, the Consultant shall:

- develop a bidimensional hydraulic and sedimentation model using HEC-RAS 2D, Delft3D, or an equivalent internationally recognized tool for selected priority reaches associated with the Delta Barrages system; base the model on the surveying that will be carried out in the study, and using the available historical bathymetric, hydraulic, hydrological, sediment, and operational data for comparison with the results of the new model.;
- use the model to improve understanding of flow patterns, velocity distribution, and sediment transport and deposition dynamics in areas where sedimentation or scour may significantly affect hydraulic performance, gate operation, structural safety, navigation conditions, or future maintenance requirements;
- complement the analysis, where necessary, with selected additional data collected under the feasibility study; and
- incorporate updated bathymetric information and relevant sediment characteristics to the extent required for feasibility-level analysis.

The Consultant shall also:



- clearly define the scope, assumptions, and level of detail of the bidimensional modelling exercise; and cross-reference these elements with the agreed budget lines and corresponding assumptions presented in the final budget and annexes

3.3.3 Optimization of the operation of the gates

The Consultants will perform the following activities:

- Examine all gate lifting and lowering systems and consider options for their potential upgrade and automation (including relevant regulating valves)
- Ensure structural soundness with the addition of energetic efficient motors and mechanisms to shift from manual to automatic operation of the various gates. The shift to a green renewable energy should be explored

The impacts of the horizontal and vertical management alternatives on the structures must be highlighted to support the technical choices. Some structural calculations will be conducted for this purpose.

3.3.4. Dynamic Control System

The last axis of modernization at the barrage level focuses on the development of a system of dynamic control and distribution of the flow thanks to the automation of the gates system through the following tasks:

- Analysis of the current water control and distribution system
- Proposal of solution for a modernized water control and distribution system
- Proposal of a decision-making process related to water allocation and taking into account the roles and responsibilities of all relevant stakeholders involved;
- Definition of a roadmap for an automated control and distribution system
- Provide draft TOR for the tendering of the development of the dynamic control system

This task shall take into account the results of the Delta water management study (§ 3.2.2) to understand:

- the process of the water demand formulation from the lower level (Farm plot / Mesqah) to the processing of the consolidated requests at the barrage level (actors involved, timing, quantity, quality and location)
- the water availability at the upstream level
- the decisions criteria to address the demand in connection with water availability
- the improvement of flexibility resulting from the automation of the group of delta barrages.

3.3.5. Modernization of Nubaria canal

The Consultant shall assess the modernization needs and options for the Nubaria Canal system, as a priority water-security corridor within the Western Nile Delta and a pilot interface for extending the modernization process from the Delta Barrages to downstream water management.

Building on the results of the Delta Equity Water Management Plan and the technical analysis of the Group of Delta Barrages, the Consultant shall carry out a targeted technical and institutional diagnosis of the Nubaria Canal system and define the main modernization options required to improve operational reliability, infrastructure performance, monitoring, modelling, dynamic control, and water allocation transparency.



The modernization assessment shall build on the hydraulic regulation structures identified under Section 2.3, including the main regulators on the Nubaria Canal and the key regulating structures on Rayah El-Behairy and Rayah El-Nassery. These assets represent critical control points for assessing hydraulic performance, infrastructure condition, gate operation practices, rehabilitation needs, monitoring requirements, and automation potential.

3.3.5.1 Diagnosis of the existing water management system

The Consultant shall, in particular:

- review the hydraulic and operational characteristics of the Nubaria Canal system and its interfaces with Rayah El-Behairy and Rayah El-Nassery;
- assess the current operating rules, data availability, monitoring coverage, and institutional arrangements governing water allocation and control;
- identify data gaps, uncertainties, operational bottlenecks, and priority hotspots affecting water security and service reliability;
- review the main institutional roles and decision-making processes related to water allocation and operation along the Nubaria Canal system.

3.3.5.2 Rehabilitation and modernization of key water management facilities

The Consultant will perform the following tasks:

- assess the current condition and performance of the main regulators, intakes, and control points relevant to the modernization scope;
- identify rehabilitation and modernization options for key water management facilities along the Nubaria Canal system;
- assess possible improvements to hydro-mechanical equipment, gate actuation systems, operability, maintainability, and automation readiness;
- identify priority canal and structure improvement measures required to enhance conveyance efficiency, operational robustness, and readiness for future modernization.

3.3.5.3 Topographic and Bathymetric Survey

The Consultant shall carry out targeted topographic and bathymetric surveys at selected priority reaches, control points, regulators, and hydraulic interfaces relevant to the modernization scope.

The purpose of these surveys shall be to provide the geometric and hydraulic data necessary for the feasibility-level diagnosis, the assessment of canal and structure conditions, and the preparation or refinement of the hydraulic model. The Consultant shall define and justify the proposed survey locations and extents based on the objectives of the study, the adequacy of the existing available data, and the requirements of the technical and modelling tasks.

The topographic and bathymetric surveys shall, as relevant, cover:

- selected reaches upstream and downstream of key regulators and control structures on the Nubaria Canal system and its relevant feeder interfaces;
- bathymetric cross-sections along the selected reaches at regular intervals of 400 m;
- additional cross-sections at closer spacing, where required, in the vicinity of hydraulic structures, bifurcations, transitions, localized bottlenecks, or other critical locations affecting hydraulic performance;
- topographic survey from the water line to the canal banks and adjacent areas, where required for the feasibility analysis; and



- any additional targeted locations where updated field geometry is necessary to support the diagnosis, modernization assessment, or model development.

All survey data shall be geo-referenced and tied, where possible, to the official benchmarks and reference systems approved by MWRI. The Consultant shall submit all raw and processed survey outputs in editable digital formats suitable for subsequent technical use and integration into the hydraulic modelling task.

3.3.5.4 Monitoring and Information System

The Consultant shall:

- define the feasibility and design principles of a Monitoring & Information System for the Nubaria Canal system;
- define measurement needs for water levels and discharges at key intakes, regulators, and control points;
- define telemetry and data transmission solutions along the canal;
- integrate climatic, meteorological, and remote sensing data, where relevant;
- define the feasibility and design principles of a centralized data platform interoperable with MWRI systems and, where relevant, with the Delta Barrages control systems;
- define operational performance indicators related to water efficiency, service reliability, and climate stress.

3.3.5.5 Water demand assessment and aggregation

As part of this activity, the consultant will:

- assess agricultural water demands in the Nubaria command area, including cropping patterns, irrigation practices, and seasonal variability;
- evaluate agro-industrial and other non-agricultural demands, where applicable;
- design methodologies for aggregating demands from local levels to canal-system scale;
- explicitly address uncertainties related to climate change, expansion of reclaimed lands, and demand variability;
- ensure consistency between the demand assessment for the Nubaria Canal command area and the broader Delta-level analysis developed under Section 3.2.

3.3.5.6 Hydraulic modelling of the Nubaria Canal system

The consultant will:

- develop, update, or refine a calibrated hydraulic model of the Nubaria Canal system and its relevant supply interfaces, using HEC-RAS or an equivalent internationally recognized tool;
- base the modelling primarily on available existing data and selected complementary investigations;
- use the model to simulate normal operations, low-flow / peak-demand situations, and emergency or extreme climate events;
- use the outputs to assess conveyance capacity and losses, identify bottlenecks and operational risks, and define constraints relevant to future dynamic control and modernization options.

3.3.5.7 Water management modelling using RIBASIM or equivalent

As part of this activity, the Consultant shall

- review any available existing MWRI water management models relevant to the Western Nile Delta system;



- develop or adapt a RIBASIM model, or an equivalent water management model, representing the Western Nile Delta system from the Delta Barrages to Rayah El-Behairy, Rayah El-Nassery, and the Nubaria Canal system;
- represent water allocation rules and priorities, integrate demand scenarios, and account for seasonal and interannual variability;
- use the model to support scenario analysis related to climate change, land reclamation dynamics, and future water management options;
- ensure that the scope of this modelling exercise remains consistent with the objectives of the feasibility study and does not extend into detailed pre-implementation design.

3.3.5.8 Integration with monitoring and dynamic control

The following task shall:

- assess how monitoring systems, hydraulic modelling, water management modelling, and decision-support tools can be integrated into a future dynamic control framework for the Nubaria Canal system;
- ensure functional coherence between data collection, analysis, modelling outputs, and operational water allocation decisions;
- support the translation of aggregated demand into operational allocation options and scenario testing for future investments and control strategies;
- provide feasibility-level guidance on how the future monitoring, modelling, and control functions could be progressively integrated within MWRI operational practice.

3.3.5.9 Governance, capacity building, and implementation guidance

The consultant will:

- clarify institutional responsibilities for water allocation and operational decision-making along the Nubaria Canal system;
- define coordination and data-sharing mechanisms among the relevant MWRI entities and stakeholders;
- identify the main capacity-building needs for operators, planners, and decision-makers involved in the future operation of the system;
- identify the main conditions required for long-term ownership, operation and maintenance, and progressive implementation of the upgraded system;
- provide guidance for the preparation of the next phases of project development, including the future tendering and implementation of rehabilitation, modernization, monitoring, modelling, and control activities related to the Nubaria Canal system.

3.3.1.10 Preliminary downstream investment needs

Where relevant, identify preliminary downstream investment needs that could be considered under a separate future project aimed at improving integrated water use and operational efficiency within the Nubaria command area.

A location map of the Nubaria Canal system is provided in the Appendix.

3.4 Environmental and Social documentation

The objectives of the present study are both to:

- provide a proportionate screening of environmental and social risks and impacts, confirm the project's classification, and specify the diligences to be undertaken in the next steps; and



- identify opportunities to maximize the project's positive environmental and social contributions. The potential positive impacts identified at this stage are summarized above (§ 2.3.3).

Given the scope of the envisioned components, namely the modernization and automation of the Group of Delta Barrages and the modernization of the Nubaria Canal system and its Western Nile Delta interfaces, the project has been preliminarily classified as Category B (moderate risks), subject to confirmation through the present study.

3.4.1 Methodological note

The environmental and social screening carried out under this study shall remain documentary in nature and proportionate to the level of information available at this stage. It shall be based on a review of existing data and documentation, the findings of the Delta Equity Water Management Plan, and the technical outputs of the feasibility study.

As the technical scope of the project, including the exact nature of the interventions, the sites concerned, and the implementation schedule, will be clarified and confirmed during the feasibility study, the Consultant shall adapt the analysis accordingly.

The E&S screening shall be conducted exclusively on the basis of secondary sources, including desk review, analysis of existing data, and consideration of available studies and regulations. No field surveys related to flora, fauna, or ecosystem services shall be undertaken under this assignment. This screening is therefore indicative at the feasibility stage and is intended to inform the project classification and the environmental and social diligences to be undertaken in the subsequent phases, depending on the confirmed classification and the level of detail available on the final project scope

3.4.2 Scoping elements

Before analyzing risks and co-benefits, the Consultant shall present:

- the institutional and regulatory context, including a review of applicable national and international frameworks and AFD's specific requirements;
- the project description, including location, technical features, planned activities, and implementation schedule; and
- the definition of the study area, including directly affected, associated, or potentially impacted areas.

3.4.3 Environmental and social risk screening

The screening shall cover risks associated with the modernization and automation works on the gates, in particular:

- Environmental: noise, dust and construction waste, management of oils and chemicals, risks of accidental water pollution, temporary disturbances of water flows.
- Biodiversity: localized impacts in construction areas and along riverbanks (disturbance of fauna, vegetation removal), with confirmation of the absence of impacts on critical habitats.
- Water: risks of disruption to existing uses, pressure on the resource, interactions with aquatic ecosystems.
- Social: working conditions and occupational health and safety of workers, safety of neighboring communities, risk of accidents, possible local disturbances (traffic, access), impacts on staff currently involved in manual gate operations.
- Resettlement: confirmation of the absence of physical or economic displacement.

3.4.4 Analysis of climate and sustainability co-benefits

In addition, the study shall highlight the project's potential positive contributions, including:



- Climate: effect of climate change by 2050 and 2100 following at least two scenarios for each horizon of time, resilience of the works (including infrastructure calibration regarding climate change perspectives), carbon footprint of scenarios, monitoring indicators aligned with AFD's matrix
- Biodiversity: opportunities for ecological restoration, reduction of existing pressures (pollution, fragmentation), enhancement of ecological corridors. The conclusions will draw on existing data to:
 - describe and map the main natural habitats (protected, sensitive, threatened and/or fragmented), their functional linkages (ecological corridors, watershed, vegetation dynamics, etc.) and an overall assessment of the impact of each project component.
 - identify existing species (protected, rare and/or threatened, migratory or gregarious, endemic, emblematic or new) and their geographic distribution;
 - give an overview of the flora (vegetation type, local species...).
 - identify the main pressure factors (biotic or abiotic) on biodiversity and possible reduction levers within the project
 - propose solutions to the identified pressure factors, in order to preserve/improve ecosystem services; promote the use of nature-based solutions as much as possible.
- Water: update the project water balance, identification of benchmarked solutions to improve water-use efficiency, potential benefits for integrated water resources management in the Delta.
- Sustainability: involvement of local stakeholders (including Water Users Associations (WUAs)) in improved system management, articulation with long-term water security planning in a context of climate change.

3.4.5 Institutional analysis

The study will include a preliminary assessment of the institutional roles and capacities of the entities involved (implementing agency, local authorities, regulatory bodies, environmental and social services) in order to identify strengths, limitations and capacity-building needs for E&S management.

The Consultant shall:

- Clarify the institutional responsibilities related to water allocation, gate operation, monitoring, data management, and decision-making processes for both the Group of Delta Barrages and the Nubaria Canal system;
- Assess existing coordination mechanisms among the relevant MWRI entities and identify needs for improved cooperation, communication, and data-sharing arrangements between the entities responsible for barrage operation, canal operation, monitoring, planning, and water distribution

3.4.6 Integrated Environmental and Social Action Plan

The consultant shall:

- Confirm the project's classification based on the risk screening and AFD's requirements.
- Propose an initial analysis of priority E&S management measures to prevent, reduce or mitigate negative impacts (e.g. prevention of accidental pollution, occupational health and safety, management of social interactions). These measures will be confirmed and detailed in the subsequent ESIA.



- Specify the diligences to be undertaken in the next steps, depending on the confirmed classification:
 - define the associated environmental and social diligences (e.g. proportionate ESIA with ESMP in case of Category B, or a full ESIA including field studies in case of Category A), and for each option specify
 - the applicable reference framework (national standards and/or World Bank standards),
 - the indicative schedule,
 - the institutional responsibilities for implementation;
 - prepare terms of reference proportionate to the identified issues to guide the studies to be launched.
- Identify actions to maximize the project's positive impacts, for example:
 - integration of measures contributing to climate resilience and carbon footprint reduction;
 - support for ecological restoration and reduction of pressures on ecosystems;
 - improvement of water-use efficiency and contribution to integrated water resources management in the Delta;
 - establishment of enhanced consultation mechanisms and participatory governance around barrage management.
- Provide an operational roadmap describing the next steps, institutional responsibilities, indicative schedule and estimated resources required for the implementation of the diligences.

3.5 Cost estimate and multicriteria analysis

To propose an investment strategy for the modernization of the Delta Barrages System and Nubaria canal, the Consultants will provide:

- A preliminary cost estimate of all modernization activities proposed above at the barrages and at the Nubaria canal level, using reference costs of comparable works and equipment in the region; in addition to the associated Operations and Maintenance costs
- A cost estimate of all accompanying project activities such as capacity building of relevant stakeholders and social and environmental mitigation actions.
- A list of potential economic impacts from the project (benefits¹⁵ and externalities) since this cost estimate will eventually feed into a larger Cost Benefits Analysis (CBA), as well as technical assumptions and criteria for the CBA.
- A multi-criteria analysis of modernization alternatives to identify the most suitable alternatives according to technical, financial as well as economic, environmental and social criteria.

3.6 Project concept note and guidance for next steps

In order for AFD to review and evaluate the rationale for the project and further support MWRI, the Consultants will:

- Prepare a detailed project description including an understanding of the context to inform a theory of change. The logical framework of the project will depict its objectives and the content of each component (including TA, capacity building and coordination activities, assumptions,

¹⁵ For example, water allocations directly increasing the efficiency of water deliveries and thus improving crop yields and allowing farmers to trust water deliveries and upgrade to higher value crops.



impact indicators...). The Consultant will indicate the resources and budget plan to achieve the project's transformational ambition in line with AFD standards.

The Consultants shall provide a description and timeline of next steps and specifically prepare:

- Guidance for the technical design of the modernization (design alternatives, construction methods, technologies)
- Development process and contents for a fair and inclusive water management plan for the Delta
- Suggestions for additional studies for project preparation and development
- Advice on institutional roles and arrangements for implementation of the project, and on procuring the next project development activities.
- An assessment of the risks given the envisioned activities and local context. This assessment will build on the potential risks pre-identified by the scoping report and will include risk mitigation recommendations;
- Guidelines for the implementation phases, including timeframe, recommendations for stakeholder engagement, further studies required for project preparation and development opportunities (downstream, green power grid hydropower potential...).
- Draft procurement plan to support the pre-identification of suppliers and consultants for the implementation phase.
- The Sustainable Development Analysis Grids developed by AFD.

4. Expected deliverables

The deliverables related to the Nubaria Canal system shall be fully integrated into the overall deliverables of the feasibility study and shall not be treated as a separate standalone package.

The final report to be delivered by the Consultant shall include:

- **A description and comparison of the modernization alternatives** from structural, hydraulic, hydromechanical, monitoring, control, environmental, social, and institutional perspectives, together with the corresponding concerns, constraints, and recommendations for additional studies where required.
- **An analysis of the current water management and allocation framework** relevant to the Delta and Western Nile Delta systems, including the assessment of existing information and decision-support systems within MWRI, and considerations for the development and implementation of a **fair and inclusive water management plan** for the Delta, together with the necessary institutional and governance adjustments and the expected benefits.
- **A preliminary cost estimate of the proposed modernization activities**, together with the identification of the main expected economic impacts, benefits, and externalities, as well as the technical assumptions and criteria required for subsequent cost-benefit analysis.
- **A feasibility-level screening of environmental and social risks and opportunities**, including biodiversity-related aspects, climate resilience considerations, and an estimate of the carbon footprint, together with recommendations for mitigation and for subsequent environmental and social diligences.



- **The project evaluation tools**, in particular the AFD Sustainable Development Analysis Grids and the project logical framework.
- **A description and timeline of the next steps** for project development and implementation, including recommendations for additional studies, advice on institutional roles and implementation arrangements, and guidance on procurement and sequencing in line with AFD requirements.

To deliver the feasibility study report, the Consultant shall prepare the following intermediary documents and milestone outputs. The final report shall be submitted 12 months after the start of service. Intermediate milestones are depicted in the below table. In addition, to help the consultant in the drafting of an exhaustive proposal, the main activities of the study are cross-referenced to the deliverable in Annex 8.4.

Deliverables	Contents	Estimated delivery date
1: Inception Report	1.a. Minutes of the inception workshop 1.b. Understanding of the project, detailed work plan	1 month after start of service
2: Fair water management plan	2.a. State of the art on water flows from the High Aswan Dam to the sea 2.b. Territorial reports of the Delta and the Nubaria Canal regarding both modernization and climate change impacts on agrosystems, ecosystems and socio-economic aspects. 2.c. Draft ToRs for a robust and sustainable Delta water management plan 2.d. Operational capitalization, communication and capacity building activities	3,5 months after start of service (2.a and 2.b) 6 months after start of service (2.c) 7 months after start of service (2.d)
3: Technical studies	Technical studies resulting from the activities outlined for the technical and water management feasibilities of the project: 3.a. Diagnosis report, including recommendations for additional investigations for the Detailed Engineering Design phase 3.b. Topographic, bathymetric and geological investigations of the Group of Delta Barrages 3.c. Hydraulic numerical modelling for the Group of Delta Barrages 3.d. Feasibility of the development of a Dynamic Control System 3.e. Technical feasibility and modernization options for the Nubaria Canal system	6 months after start of service for 3.a (draft diagnosis report 4 months after start of service) 6 months after start of service for 3.b and 3.c 8 months after start of service for 3.d and 3.e
4: Environmental & social documentation	4.a. Identification & assessment of social and environmental risks 4.b. Biodiversity assessment 4.c. Estimate of the carbon footprint 4.d. Risk mitigation recommendations. 4.e. Suggestions for refining assessment of environmental & social impacts	6 months after start of service



5. Cost assessment and multicriteria analysis	5.a. Preliminary cost estimate of all modernization activities 5.b. List of potential economic impacts (benefits and externalities) 5.c. Assumptions and criteria for future Cost-Benefit Analysis	10 months after start of service
6: Final report and project documentation	6. The final report will include the above validated deliverables and the project documentation outlined in § 3.6	12 months after start of service

The Consultant shall establish and maintain a robust quality assurance system, including internal reviews, cross-checks, and validation procedures, to ensure that all deliverables meet the required technical and professional standards prior to submission. All deliverables shall be submitted within the agreed timelines. Any delay shall be promptly communicated, together with a valid justification and the proposed corrective measures.

All deliverables shall be subject to review and formal validation by **AFD in coordination with MWRI**. Upon receipt of each deliverable, AFD shall have **10 working days** to review the submission and provide comments. Where comments are issued within that period, the Consultant shall have **10 working days** to address them and submit a revised version of the deliverable. This review process may be repeated, where necessary, until the deliverable is formally accepted by **AFD and MWRI**.

All deliverables shall also be reviewed by the relevant technical team of **MWRI**. The Consultant shall ensure that all reports, technical outputs, supporting materials, and analytical results are submitted in a form that enables effective review, verification, and subsequent use by MWRI.

In addition, the Consultant shall hand over to **MWRI** all primary, processed, and raw data generated under the assignment, including without limitation, topographic and bathymetric survey data, raw and processed survey outputs, hydraulic and water management models, model input and output files, GIS layers, databases, and all supporting technical documentation. All spatial data shall be submitted in editable and reusable GIS-compatible formats, including shapefiles, together with complete metadata, file structures, naming conventions, methodological notes, and any other documentation required to ensure their effective review, update, integration, and future use by MWRI.

To assess the quality of the deliverables, **AFD and MWRI** shall apply the following criteria:

- compliance with the expected scope;
- soundness and technical robustness of the approaches adopted;
- clarity, consistency, and readability of findings and recommendations; and
- respect of agreed deadlines.

As indicated, deliverables shall be submitted, as relevant, in **Word, Excel, PowerPoint, PDF, and other editable digital formats**, including **GIS-compatible formats such as shapefiles**, together with all associated raw data, metadata, databases, model files, and supporting documentation

5. Implementation modalities

5.1 Estimated level of effort and timeframe

The Consultant shall provide approximately 540 person-days of experienced professionals for the completion of all activities under this feasibility study over an indicative period of twelve months. The bid submission is planned for June, and the services are expected to commence in September.



The Consultant shall organize the assignment in such a way as to ensure timely delivery of all outputs and adequate coordination with MWRI and AFD throughout implementation.

The offer shall present the key milestones for the start of each work package, as well as the intermediary and final deliverables. Regular interaction with MWRI and AFD shall ensure proper progress monitoring and consistency between the different outputs

5.2 Expected methodology and coordination

The Consultants may propose the methodology deemed most appropriate (based on best international practices) to carry out the activities of this feasibility study, in agreement with AFD and the MWRI.

This methodology is expected to:

- Leverage existing documentation and data
 - Topography of the delta, geology, rainfall, hydrology etc.
 - Demographics, urban planning and land use with a focus on the Delta.
 - Data in relation to climate change, including national and international databases, climate evolution models, etc.
 - Institutional, legal and regulatory information relating to the governance of Nile Basin (legal bases and organization schemes);
 - Modelling tools used to characterize hydrology, water demand, water allocation
 - Prospects of water supply evolution under climate change and international development scenario (the consultant shall refer to the most up-to-date and precise future climate data (2050). It will consider a trend scenario of the evolution of the concentration in GHG (preferability SSP3-7.0 with at least another scenario);
- Apply sound, evidence-based methods that are suitable for the objectives of this assignment. All findings and recommendations and outputs should be supported by thorough analysis, data, and evidence. The consultant should ensure that the methods used are robust, reliable, and replicable where applicable.
- Use innovative and cost-effective approaches that enhance efficiency, effectiveness, and impact whilst assuring compliance with local regulations (geospatial data, drone and radar investigations, etc.)
- Tailor approaches to the local context, project needs, and stakeholder requirements, demonstrating flexibility and responsiveness to emerging information and circumstances
- Maintain clear records of methodological choices, assumptions, and innovative approaches applied, allowing for transparency, accountability, and knowledge sharing.
- Meet highest standards of quality, accuracy, and professionalism. This includes adherence to relevant national and international standards, as well as best practices in the field.
- Adhere to the highest ethical standards, including integrity, confidentiality, and respect for all stakeholders involved in the assignment
- All data, documents, records, and information required for the assignment shall be obtained exclusively through the Ministry of Water Resources and Irrigation (MWRI). The Consultant shall not directly contact, request information from, or correspond with any other ministries, authorities, agencies, companies, or external entities outside MWRI unless expressly authorized in writing by MWRI. Where coordination with external parties is deemed necessary,



such coordination shall be undertaken solely through MWRI and in accordance with its instructions and official channels

The Consultants will engage closely with MWRI through field visits and meetings/interviews to support the preparation of this feasibility study. Any engagement with other partners or competent authorities, where deemed necessary, shall be coordinated exclusively through MWRI and subject to its prior approval. They will liaise with the competent authorities, through MWRI, to ensure that the methods and procedures adopted comply with Egyptian legislation and regulations related to undertaking environmental and technical studies

Meetings with MWRI management and representatives of AFD will be held at key moments of the assignment. The updated list of consulted documents and the minutes of main interviews/meetings will be provided in the deliverables

Regular updates on progress should be provided, and any issues or challenges encountered should be communicated in a timely manner. The consultant is expected to be responsive to feedback and to engage in constructive dialogue with both AFD and MWRI

5.3 Implementation requirements / contact persons

The contract will be performed under the responsibility of Sandra Rulière (ARB Division deputy manager). The Team Task Leaders will be Béatrice Ki-Zerbo and Quentin Ballin from ARB assisted by AdaptAction coordinator for North Africa Augustin Jeanjean. An AFD team at the headquarters and the country office will monitor the study in coordination with the MWRI.

The Consultants will appoint a single contact person responsible for leading/supervising this contract. Site visits and meetings with officials (Ministries, implementing agencies...) will require security clearances for non-Egyptians. The Consultants will ensure the availability of local experts to ensure interactions with local stakeholders and that any clearances won't jeopardize the project timeline.

The Consultants will closely coordinate with MWRI officials, especially the Reservoir and Grand Barrages Sector (RGBS) and the General Authority for Delta Barrages Irrigation. When available, the MWRI may assign qualified staff to assist the Consultants in data collection, meetings, and field visits. The Consultants shall ensure that appropriate knowledge transfer occurs between their team and the local staff.

The Consultants will also coordinate with relevant national and international key stakeholders that might be identified during the study, such as other donors implementing water, irrigation or agricultural projects in Egypt.

AFD will provide the consultants with all relevant documentation necessary for the requested services in accordance with the scope of work. The Consultant mobilizes his team a maximum of one week after signing the contract.

5.4 Applicable Languages

English must be invariably used in documents, meetings, reports, telephone calls, e-mails, all deliverables, etc. Arabic can be necessary for some interactions (especially in technical discussions and site visits) and an Arabic version of the executive summary of the deliverables will be provided.



6. Expected Qualifications

The Consultants should possess the necessary expertise and experience to carry out the tasks outlined in this ToR. This includes a proven track record in similar assignments and the ability to apply sound judgment and technical skills.

They shall assign employees with the appropriate qualifications and experience to achieve the activities and deliverables described in these specifications. More specifically, the consultant team must involve employees with expertise in the following capacities (the below list is not comprehensive; the consultant is responsible to mobilize the necessary experts to meet the requirements of the ToR such as IT, infrastructure engineer, etc...):

Position	Required capacities
Team Leader	The Team Leader should at least hold a Master's Degree or equivalent qualification in civil engineering, water resources or similar related field He/She shall have a minimum of ten (10) years' experience in leading international funded studies on integrated water resource management/operation and maintenance of large barrages, including several experiences on project feasibility studies with international financing institutions especially AFD Experience in environmental & social impacts assessment (including climate change risks, biodiversity and social inclusion, etc....) of water management and irrigation projects in similar contexts following international standards such as World Bank E&S framework. Experience working with local organizations in charge of implementing water planning and/or irrigation activities in Northern Africa (especially in Egypt) is an asset. Ability to engage stakeholders and lead other specialists
Civil/structural & Water Resources Engineer(s)	The Civil/structural & Water Resources Engineer(s) should at least hold a Master's Degree (with 10 years of experience) or a Bachelor's Degree (with 15 years of experience) or equivalent qualification in civil engineering, water resources or similar related field. He/She shall have the minimum years of experience in designing, constructing, rehabilitating or assessing complex water infrastructure such as the Delta barrages, with a keen understanding of hydraulics around such structures and conditions for their stability. Experience using computer models and assessing flow patterns through such structures and the operation of large gates releasing significant discharges.
Hydrology specialist	The hydrologist should at least hold a Master's Degree (with 10 years of experience) or a Bachelor's Degree (with 15 years of experience) or equivalent qualification in water resource planning and conservation. He/She should have the minimum years of experience as professional engineer, with experience in water planning, water monitoring, irrigation, and water data management. Experience using computer models to assess water balances of large river basins, and keen understanding of the impacts of climate change on hydrologic forecasting.
Mechanical Engineer	The mechanical engineer must hold at least a Master's degree (with 10 years of experience) or a Bachelor's Degree (with 15 years of experience) or equivalent in his field of specialization



	He/She should have the minimum years of experience in gate operation, maintenance, and rehabilitation of barrages and dams
Electrical Engineer	The electrical engineer must hold at least a Master's degree (with 10 years of experience) or a Bachelor's Degree (with 15 years of experience) or equivalent in his field of specialization He/She should have the minimum years of experience in gate operation, maintenance, and rehabilitation of barrages and dams
Agricultural Economist	The Agricultural Economist should at least hold a Master's Degree (with 10 years of experience) or a Bachelor's Degree (with 15 years of experience). He/She should have the minimum years of experience in the analysis of economic benefits from agricultural development projects, and the economic benefits of changing agricultural cropping patterns Experience working with irrigation and/or agricultural activities in Northern Africa (especially in Egypt) is an asset.
Social & environmental specialist(s)	The Social and Environmental specialist must possess a minimum of B.Sc. Degree or equivalent in Environmental Management or Environmental Technology/Science or similar. He/She should have a minimum of seven (7) years of experience in developing environmental and social guidelines and assessments. The specialist shall have proven experience with government institutions and international financial institutions including WB relevant standards
Climate Change Specialist	The Climate Change Specialist should hold at least a Master's degree in environmental sciences, climate change, natural resource management, or a related field. He/She should have a minimum of seven (7) years of experience in climate risk assessments, adaptation and resilience planning, and in the integration of climate change considerations into investment projects, particularly agriculture and/or hydrological projects. He/She should demonstrate proven experience in climate resilience and carbon footprint modeling as well as experience in assessing the impacts of climate change on agricultural livelihoods and on rural populations. Experience in Northern Africa, Semi-Arid Economies (especially Egypt), combined with strong analytical, advisory, and stakeholder engagement skills, will be considered an asset.

Specific attention will be brought to the diversity and complementarity of team members. All team members must be fluent in English.

Consulting firms should demonstrate their capacity to deploy the relevant competencies and qualifications. Moreover, the interested firms should be able to identify and mobilize pertinent local competencies in Egypt to interact with local authorities in full autonomy. All experts recruited should be independent and their responsibilities should not place them in a position of conflict of interest. More specifically, civil servants or any other person working in the public administration of the beneficiary country and who might be linked to the project could not be recruited as experts.

7. Available resources

AFD will provide the following:



- Scoping report for “Resilient water management system: Automation of group of Delta Barrages & development of Irrigated areas directly related” to the bidders upon request and provision of a signed confidentiality certificate.

As well as AFD operational documentation for the preparation of inception report:

- National Water Resources Plan (2017 – 2037)
- [Egypt National Climate Change Strategy](#)
- A guide to AFD's logical framework approach
- Model for stakeholder analysis and institutional environment analysis
- AFD [Sustainable Development Analysis and Opinion Mechanism](#);
- [AFD institution results and impacts framework](#) and relevant sectorial indicators
- Carbon footprint tool
- Any other relevant tools and templates.

World Bank guidance documents should also be consulted:

- ESCP [Environmental and Social Framework Resources](#)
- ESMF for low and moderate risk [Environmental and Social Framework Resources](#)
- Water use : [ESF-Water-Use-Good-Practice-Note.pdf](#)
- Dam safety [Open Knowledge Repository](#)
- [Good Practice Note. Environmental & Social Framework for IPF Operations Water Use](#)
- Water resources [Best Practices](#)

It is understood that the MWRI will make available, **at the beginning of the assignment**, all relevant data, information, and reports in their possession such as:

- Existing technical drawings, detailed diagram and longitudinal profiles of the group of barrages
- Historical maps and data relative to the bathymetry and the sedimentation upstream and downstream of the group of barrages to support the sedimentation dynamics study
- Reports and results of investigations: geological investigations, geotechnical investigations, materials characterization, defects detection, etc.
- Operation and Maintenance costs related to the group of barrages: time series of annual energy consumption detailed by headworks, human resources affected to the operation and maintenance of headworks, annual routine maintenance budgets and budgets affected to extraordinary maintenance operations (such as radial gates repainting for Menofi and Tawfiki)
- Agricultural statistics for the 9 governorates of the delta for at least 10 years: crops, crop budgets, yields, market price, etc.
- Background studies regarding the environmental and social situation in the Delta
- Executive files of the RIBASIM OR EQUIVALENT, SIWARE, DELWAQ, ASME models and their associated simulation reports
- Existing reports and appendixes regarding the Nubaria canal and its command area
- Daily time series of flows across the group of barrages for the last 10 years
- Time series of water flow and water withdrawals for the Nubaria canal for the last 5 years
- Past current and upcoming relevant development projects (JICA on the development of the Dayrout modernization project)



8. Annexes

8.1 Key features and location of the Delta Barrages and Nubaria Canal



Source: National Water Ressources Plan for Egypt

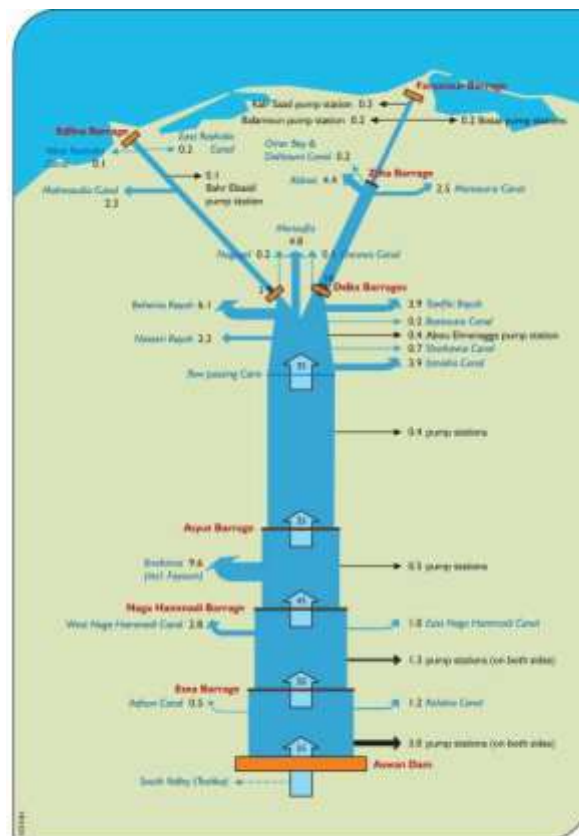
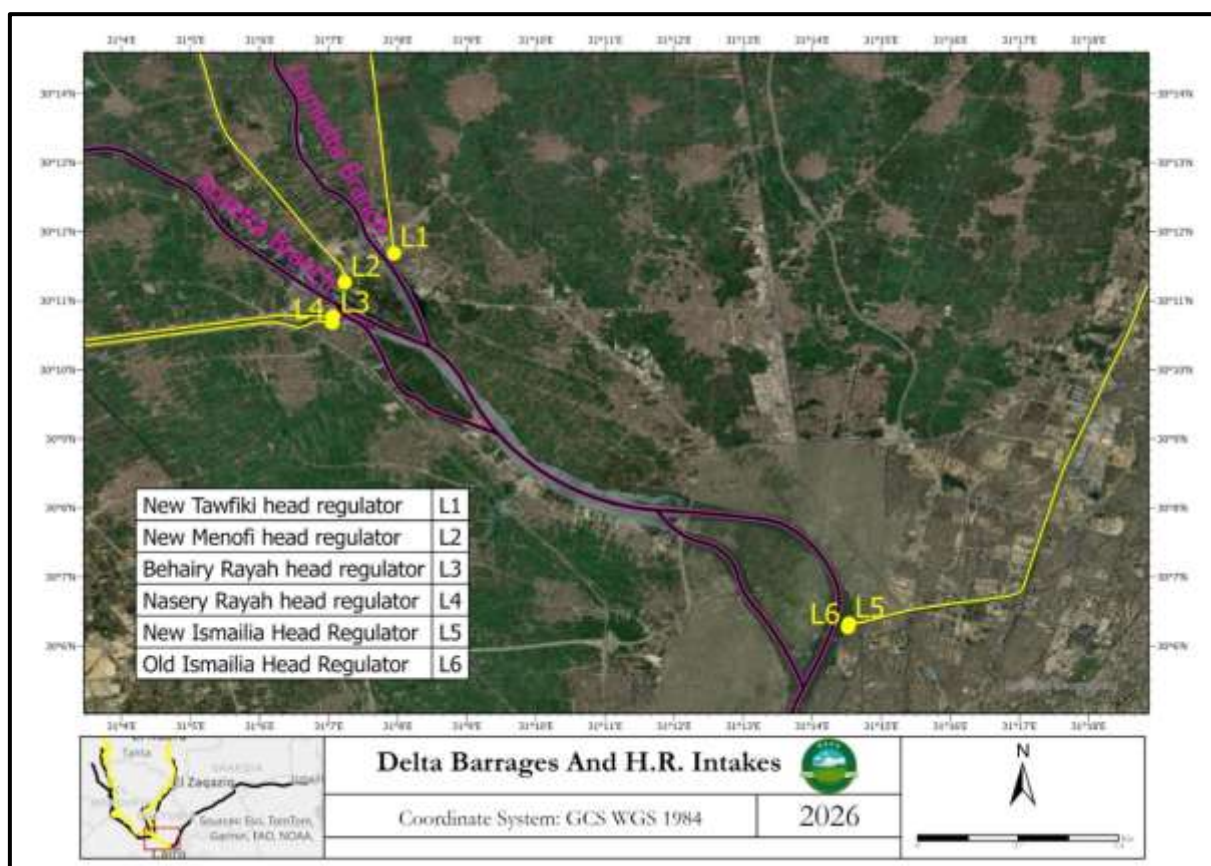
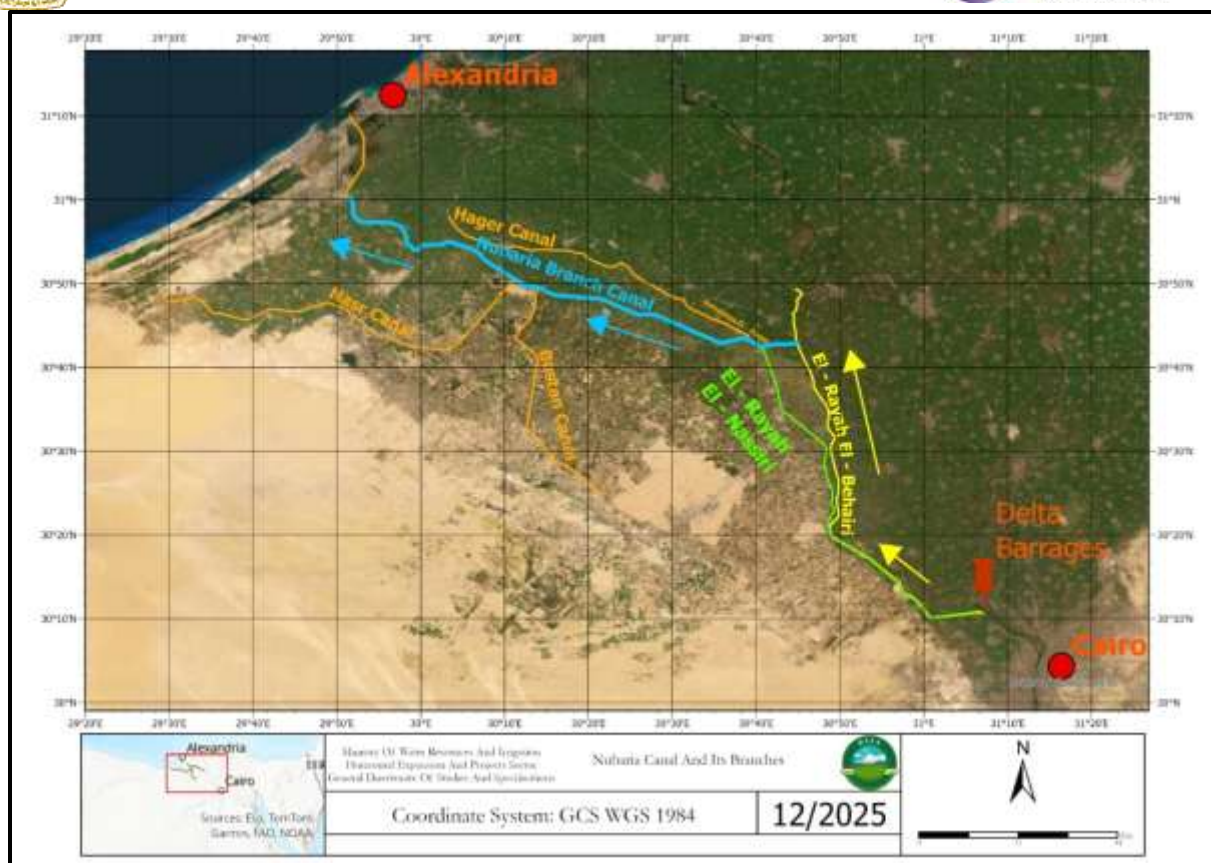


Figure 3.7 Water distribution Nile System (source: NAWQAP project)





8.2 Hydraulic Control Structures associated with Nubaria Canal System

The Nubaria Canal system shall be considered within its broader hydraulic and operational framework, as it is not supplied through a single isolated control point but through an interconnected chain of regulating structures linked to the Delta Barrages system through Rayah El-Behairy and Rayah El-Nassery. In addition to the main regulators located along the Nubaria Canal itself, the relevant control structures on the feeder rayahs play a direct role in governing water conveyance, regulation, and distribution toward the canal system. Accordingly, the hydraulic regulation system associated with the Nubaria Canal includes the **El Nubaria Head Regulator** at km 0.00, the **El-Bostan Intermediate Regulator** at km 28.54, and the **Khankalis Intermediate Regulator** at km 60.64. It also includes the principal control structures on **Rayah El-Behairy**, namely **El-Khattatba Intermediate Regulator** at km 41.5 and **Boulin Intermediate Regulator** at km 82.1, as well as the key regulating structures on **Rayah El-Nassery**, namely **Al-Mahoulat Intermediate Regulator** at km 70.0 and **Abdelhady Intermediate Regulator** at km 80.0. These structures collectively form the main hydraulic control chain governing water conveyance toward the Nubaria Canal and should therefore be explicitly considered in the project rationale, the technical diagnosis, and the subsequent assessment of modernization, monitoring, and dynamic control options in the Western Nile Delta.

The main hydraulic regulation structures associated with the Nubaria Canal system and its feeder rayahs are presented below:

Main Regulators on Nubaria Canal

Structure name	Kilometric location (km)	No. of vents	Vent width (m)	Sill level under gate (m)
El Nubaria Head Regulator	0.00	5.00	5.00	4.70
El-Bostan Intermediate Regulator	28.54	6.00	5.00	3.35
Khankalis Intermediate Regulator	60.64	4.00	3.50	2.25

Main Barrages on Rayah El-Behairy

Structure name	Kilometric location (km)	No. of vents	Vent width (m)	Sill level below gate (m)
El-Khattatba Intermediate Regulator	41.5	9	5	8.20
Boulin Intermediate Regulator	82.1	5	5	5.21

Main Barrages on Rayah El-Nassery

Structure name	Kilometric location (km)	No. of vents	Vent width (m)	Sill level under gate (m)
Al-Mahoulat Intermediate Regulator	70.000	5	5	7.700
Abdelhady Intermediate Regulator	80.000	5	5	7.400



8.3 Lateral intakes along Nubaria Canal

As indicated in the following table of lateral intakes along the Nubaria Canal, water distribution is operated through rotation groups. Accordingly, the water management analysis shall include no fewer than 20 lateral intakes within one rotation group, in order to capture the operational reality of the canal and provide a representative basis for assessing water allocation, service reliability, and distribution performance under the prevailing rotational regime.

Serial No.	Intake	Kilometer (km)	Rotation Group	Discharge (m ³ /s)	Command Area (feddan)
1	Ganabeyet El-Baidawi	0.140	A	0.50	250
2	Ganabeyet Hod El-Selah	0.800	A	0.20	200
3	Ganabeyet Hod El-Fallaha	1.300	A	0.35	450
4	Ganabeyet El-Sherif	2.475	A	1.10	1,500
5	Farhash Canal	3.180	Triple	25.00	82,190
6	Ganabeyet Shubra Osim	3.330	A	0.30	370
7	Ganabeyet El-Hager	9.970	A	2.36	30,000
8	El-Hager Canal	10.000	Triple	28.00	91,980
9	Ganabeyet El-Gayar	10.100	A	0.75	950
10	Ganabeyet El-Sherka	15.290	A	0.50	850
11	Ganabeyet Youssef Abdel Malek	16.600	A	0.45	580
12	Ital-Consult Intake	17.700	A	0.60	800
14	Ganabeyet Fahmy	19.080	A	0.50	1,150
15	Ganabeyet Hod El-Gabal	22.100	A	2.25	3,000
16	Ganabeyet Hod El-Nubaria	29.180	A	2.20	2,800
17	Ganabeyet Sultan	32.800	A	0.45	550
18	Ganabeyet Omara	37.300	A	0.40	4,000
19	Ganabeyet Wassef	42.100	A	1.20	1,500
20	Abdel Kader Canal	47.700	B	3.00	2,700
21	Ganabeyet El-Bank	47.710	B	0.85	1,150
22	Ganabeyet El-Selmaya	49.400	B	0.25	220
23	Ganabeyet El-Haddad	51.590	B	1.85	4,500
24	El-Bostan Canal	52.000	C	29.00	125,000
25	Egyptian Company Distributor	54.710	C	0.75	1,050
26	Ganabeyet Baghos	55.600	C	10.16	4,600
27	Ganabeyet El-Gamae	56.900		1.50	3,050
28	El-Nasr Canal	57.500			383,619
29	El-Barayeb Mesqa Canal	59.510	C	1.40	1,950
30	Ganabeyet Tharwat	60.840	C	0.30	1,850
31	Ganabeyet Karam	65.000	B	0.50	1,200
32	Ganabeyet Sednaoui	66.980	B	1.90	2,500
33	Everest Canal	69.400	B	1.50	3,000
34	Ganabeyet Hammad	69.850	A + B	4.40	51,200
35	El-Moshtarak Canal	73.017	B	3.60	4,500



Serial No.	Intake	Kilometer (km)	Rotation Group	Discharge (m³/s)	Command Area (feddan)
36	Ganabeyet Abu El-Wafa	73.035	B	0.75	500
37	Ganabeyet Abdel Kader	75.560	B	1.50	3,000
38	Ganabeyet Mehrez	76.585	Triple	1.50	2,000
39	El-Tharwa Canal	79.400	B	18.40	33,660 + lift
40	Ganabeyet El-Seirafi	80.740	Triple	0.75	Lift
41	El-Tahrir Canal Intake	82.150	C	2.00	5,000
42	El-Noubaria Canal Relief	84.800	A	25.00	1,255 + lift
43	Main Feeder	85.380	C	3.50	Lift
44	March 4th Branch	86.000	Triple	55.00	31,500
45	March 3th Branch	90.000	B	23.35	5,000
46	El-Sahary Canal Intake	95.700	A + B	1.50	7,000
47	March 2nd Branch	97.270	Triple	2.25	10,400 + lift
48	March 1nd Branch	99.380		3.00	Lift
49	El-Noubaria Canal Branch Intake	99.500			3,500
50	El-Sahary Drain Outfall	101.000			6,000
51	Right Bank Outlet	110.000			4,450
52	Left Bank Outlet	112.000			



8.4 Main activities of the study organized by deliverables¹⁶

Key deliverables	Deadline	Contents	Section of the ToR	Main activity	Key sub-activity
1: Inception Report	1 month after start of service	a. Minutes of the inception workshop	§4	Crosscutting	
		b. Understanding of the project, detailed work plan			
2.Fair water management plan	3.5 months after start of service	a. State of the art on water flows from the High Aswan Dam to the sea	§3.2	Studies and models review Institutional and governance analysis	Review studies and models of U/S Water Availability
					Review studies and models of Future D/S Water Demand under scenarios
					Institutional and governance analysis of water management arrangements at Nubaria canal and their implications for water security
	3.5 months after start of service	b. Territorial reports of the Delta and the Nubaria Canal regarding both modernization and climate change impacts on agrosystems, ecosystems and socio-economic aspects.	§3.2 3.3.5	Specific analysis around the Delta barrages and Nubaria Canal	Review studies and models for water management (including drainage and salt balance) under future conditions
					Collection, review and consolidation of existing studies, datasets and operational documentation relevant to the Nubaria Canal and Rayah El-Behairy system
					Workshops organization on desirable adaptation pathways and agro socioeconomic future.
					Assessment and classification of current and future water demands, including agricultural, agro-industrial, seasonal and climate-related variations at Nubaria Canal
					Water management modelling and characterization of water security issues, shortages and system vulnerabilities at Nubaria Canal
					Review the present Institutional situation and develop future scenarios
					Institutional and governance analysis of water management arrangements at Nubaria and their implications for water security
				Institutional and governance scenarios	Institutional analysis for implementation, governance and long-term operation of the project at Nubaria

¹⁶ This table is only a summary to facilitate the preparation of the proposals. The evaluation of offers will be based on the activities detailed in the tors



	6 months after start of service	c. Draft ToRs for a robust and sustainable Delta water management plan	§3.2	Prepare the Terms of Reference for the development and implementation of the Delta Equity Water Management plan	
	7 months after start of service	d. Operational capitalization, communication and capacity building activities	§3.2 3.5.5 3.4	Leveraging the above institutional analysis and scenarios as well as the relevant E&S documentation	Information and valorization of the work analysis through operational deliverables and workshops.
3: Technical studies	4 months after start of service	a. Diagnosis report, including recommendations for additional investigations for the Detailed Engineering Design phase	§3.3	Investigation of the gates and their operating systems	Visual Investigations of Civil Works (Surface & Submarine)
					Visual Investigations of Gates
					Investigations of mechanical and electromechanical moving devices (Chains, cranes, motors...)
					Analysis of O&M procedures
	6 months after start of service	b. Topographic, bathymetric and geological investigations of the Group of Delta Barrages.	§3.3	Topographic and bathymetric surveys	Draft diagnosis report based on the investigation (4 months) to be finalized within 6 months with content 3.b and 3.d
					Topographic survey of the Group of Delta Barrages
					Digitalization of existing technical drawings and control of dimensional accuracy
					Submarine bathymetric survey of Headworks (4 km Upstream - 2 km Downstream - 25 m sections)
					Semi Detailed bathymetric survey of the upper pool (30 km Upstream - 20 km Downstream - 500 m sections)
			§3.3	Geological and geotechnical investigations	Review of existing studies and data regarding geology, geotechnics and headworks footings
					Water turbidity and sediment characterization (Sample and analysis)
					Mapping of sedimentation dynamics and present sedimentation situation
	6 months after start of service	c. Hydraulic numerical modelling for the Group of Delta Barrages	§3.3	Hydraulic numerical modeling of the Group of barrages (HEC RAS or Equivalent)	Develop 2-D Hydraulic model for each barrage (- Nasri Beheira - Rosetta - Menofi - Damietta - Tawfiki - Ismailia Intake) Develop alternatives for vertical or horizontal evolution of gates Conduct simulations and conclude on alternatives



				Reservoir simulation model for the Group of Barrages (HEC Res Sim or Equivalent)	Build model based on Pool Characteristics, Inflow time series and Scenarios of Dynamic Water demand Build a set of alternatives and test simulations
				Bidimensional model of the Group of Barrages to study sedimentation dynamics	Build model based on results of bathymetric survey and previous mapping activities Define and study scenarios to document the sedimentation process, the dredging requirements and the future strategy for Sediments management
				Hydromechanical analysis of the gates' operation modernization	Definition of repairs and rehabilitation needs Develop alternatives for gates automation
				Structural analysis of barrages evolution	Structural Calculations
	8 months after start of service	d. Feasibility of the development of a Dynamic Control System	§3.3	Preparation of the Dynamic control system (incl. Monitoring & Information System) of the barrages	Analysis of the current Water Control system Proposed modernization of the water control
					Definition of a roadmap for a Decision Support System and an automated control
	8 months after start of service	e. Technical feasibility and modernization options for the Nubaria Canal system	§3.3	Preparation of the technical modernization of the Nubaria canal	Complementary field investigations, topographic and bathymetric surveys, and gap assessment to support hydraulic and water management modelling Hydraulic and operational modelling of the Nubaria Canal system Technical analysis and definition of modernization options for integrated monitoring, modelling and dynamic control
4: Environmental & social documentation	6 months after start of service	a. Identification & assessment of social and environmental risks	§3.4	Preparation of E&S risks and impact documentation	Re view of existing studies, preliminary screening of the Group of barrages, recommendations for additional E&S investigations for the preparation of the ESMP
		b. Biodiversity assessment			Environmental, climate and social screening of Nubaria Canal
		c. Estimate of the carbon footprint			Carbon Footprint Analysis
		d. Risk mitigation recommendations			ES documentation resulting from the above activities and the institutional analysis (cf. water management plan activities above)
		e. Suggestions for refining assessment			



		of environmental & social impacts			
5. Cost assessment and multicriteria analysis	10 months after start of service	a. Preliminary cost estimate of all modernization activities	§3.3 3.5	Cost analysis, multicriteria analysis for the selection of the most suitable alternative	Cost Analysis of Alternatives for the operation of the gates
		b. List of potential economic impacts (benefits and externalities)			Multicriteria analysis of the project for the selection of the most suitable alternative
		c. Assumptions and criteria for future Cost-Benefit Analysis			Economic, financial and climate resilience analysis of the proposed modernization options of the project
6: Final report and project documentation	12 months after start of service	a. The final report will include the above validated deliverables and the project documentation	§4	Crosscutting Above deliverables, project concept note and guidance for next steps i	Above deliverables, project concept note and guidance for next steps
				Procurement documentation	ToRs such as those regarding (The development and implementation of the Delta Equity Water Management plan; The development of the Dynamic Control System; The Modernization of Nubaria Canal Water Management; DED and Works Supervision)